

should be allowed. Reconsideration and allowance are therefore respectfully requested.

Before addressing the grounds upon which the rejections are founded, it is believed useful to briefly summarize the essence of the invention "dry process" for providing a uniform and reproduceable surface of low-resistance electrical contact between a metal and a layer of p-type CdTe surface of a semiconductor device.

Applicant is the first to invent a "dry process" for making a uniform and reproduceable surface of low-resistance electrical contact between a metal and a layer of p-type CdTe surface through the use of a unique form of ion beam processing.

The invention process is accomplished by:

- a) placing a CdS/CdTe device into a chamber and evacuating the chamber to create a vacuum;
- b) orientating the p-CdTe side of the CdS/CdTe device to face apparatus capable of generating Ar atoms and ions of preferred energy and directionality;
- c) introducing Argon and igniting the area of apparatus to generate Ar atoms and ions of preferred energy and directionality in a manner so that during ion exposure, the source-to-substrate distance is maintained such that it is less than the mean-free path or diffusion length of the Ar atoms and ions at the vacuum pressure; and

d) allowing exposure of the p-CdTe side of the layer to the ion beam for a period less than about 5 minutes.

Claims 1-4 were rejected as being unpatentable over admitted prior art in combination with Schroen et al. under 35 U.S.C. §103(a).

Applicant respectfully traverses the rejection and requests reconsideration for the reasons hereinafter elaborated.

While the "admitted prior art", which applicant presumes is that cited on pages 5 and 6 of its specification discloses methods of making CdS/CdTe devices, these processes clearly lack teaching a "dry process" for providing a uniform and reproduceable surface of low-resistance electrical contact between a metal and a layer of p-type CdTe surface of a semiconductor, let alone suggesting, teaching or disclosing exposing the p-type CdTe to Ar ions or atoms to reduce contact resistance.

The deficiencies which encumber these "admitted prior art" references are not compensated for by any teachings or disclosure in the secondary reference of Schroen et al.

This is so because, Schroen et al. is directed to a process for fabrication of a semiconductor ohmic contact structure comprising:

a. exposing a selected portion of a semiconductor body to a glow discharge in the presence of an inert gas;

b. exposing the selected portion to a glow discharge in oxygen or nitrogen, at conditions selected to form an adherent uniform film of nonconductor 10-100 Angstroms thick on the selected portion of the semiconductor body; and

c. forming an adherent film of conductor on the nonconductor film, to complete a contact structure having linear I-V characteristics.

Clearly, the Schroen et al. patent deals with crystalline Si, and not a polycrystalline CdTe (which is a II-VI material).

Further, the only specific material on which the process of Schroen et al. has been demonstrated is crystalline Si. However, Si forms a stable oxide and this oxide is non-reactive with most metals.

More importantly, Schroen et al. discloses the use of a "glow discharge in the presence of an inert gas" specifically to activate the Si surface for a subsequent formation of "an adherent uniform film of non conductor".

On the other hand, and by contrast, applicant's invention is directed to use of an ion-beam process to condition a polycrystalline p-CdTe surface prior to deposition of an additional semiconductor layer. In other words, the invention process is not conditioning the surface to facilitate formation of a non conductor - but rather a semiconductor.

Further, the ion dynamics and the plasma chemistry occurring

in the surface of the clean crystalline Si, and caused by exposure to a 1-10keV glow discharge of Schroen et al., which is high-voltage, high-pressure is vastly different from the 0.05-2keV ion-beam exposure (low-voltage, low-pressure) of the CdCl₂-treated polycrystalline p-CdTe of the invention process.

The improvement in the interfacial current transport at the p-CdTe interface of the invention is by improved alignment of the valence bands between semiconductors. By contrast, the improvement in current transport of the Si/oxide/metal interface of Schroen et al. is by the creation of "a semiconductor-insulator interface with suitable electrical properties to create an accumulation in the adjacent semiconductor."

Therefore, even if the "accumulation layer" would improve quantum-mechanical tunneling between a semiconductor and a metal, it nevertheless represents very different physics of interfacial current transport, and the process used to provide optimal "activation" of a Si surface is drastically different than the invention process which is used to prepare the surface of a p-CdTe film.

Accordingly, the combination of Schroen et al. with "admitted prior art" cannot be reconciled under the provisions of 35 U.S.C. §103 for purposes of rendering claims 1-4, especially as amended, obvious.

Withdrawal of the rejection is respectfully requested.

Claim 5 has been rejected as being unpatentable over "admitted prior art" in combination with Schroen et al., further in view of Lee et al. under 35 U.S.C. §103(a).

Applicant respectfully traverses the rejection and requests reconsideration for the following reasons.

The "admitted prior art" and Schroen et al. have been discussed at length above.

The collective deficiencies in the "admitted prior art" and Schroen et al. are not provided for in the teachings of the Lee et al. reference.

Lee et al. is directed to an external plasma gun that provides both ions and electrons for bombarding substrates. There is no reference to or acknowledgement of the use of this external plasma gun to condition a polycrystalline p-CdTe surface prior to deposition of an additional semiconductor layer. Therefore, the fact that an exit aperture having a diameter of 3cm is disclosed would provide no incentive for or reason why one skilled in the art would be led to utilize this external plasma gun with an aperture of 3cm in one of its specific embodiments for use as an ion-beam in combination with Schroen et al. and the "admitted prior art" to condition a polycrystalline p-CdTe surface prior to deposition of an additional semiconductor layer.

Withdrawal of the rejection is respectfully requested.

Claim 6 was rejected as being unpatentable over "admitted

prior art" in combination with Schroen et al., further in view of Ebe et al., under 35 U.S.C. §103(a).

Applicant respectfully traverses the rejection and requests reconsideration for the reasons hereinafter explained.

All of the "admitted prior art" and Schroen et al. have been discussed supra.

Ebe et al. is directed to a method for manufacturing film carrier type substrates in a vacuum by depositing a metal vapor on a film made of organic high molecular substance and irradiating accelerated nitrogen gas ions on the film simultaneously with the step of depositing metal vapor.

The teachings of Ebe et al. are non-related to those of the "admitted prior art" and Schroen et al. for the reason that Ebe et al. is directed to providing a carrier type substrate that includes the film of organic high molecular weight substance and a metal formed thereon to effect high density mounting of integrated circuits to obtain super-adhesive characteristics. Accordingly there would be no incentive or reason why one skilled in the art of making CdS/CdTe devices by conditioning a polycrystalline p-CdTe surface prior to deposition of an additional semiconductor layer by looking to the art of obtaining super adhesion between an organic high molecular weight substance and a metal layer formed thereover and an appropriate exposure angle of an ion beam source for making a uniform and

reproduceable surface of a low-resistance electrical contact between a metal and a layer of p-type CdTe surface.

Accordingly, the combination of "admitted prior art" with Schroen et al. and Ebe et al. cannot be reconciled under the auspices under 35 U.S.C. §103 for rejecting claim 6 as presently recited.

Withdrawal of the rejection is respectfully requested.

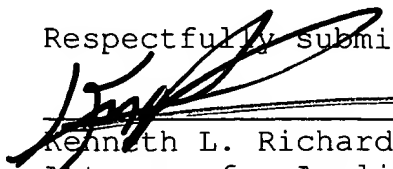
Claim 5 was rejected under the second paragraph of 35 U.S.C. §112 on the allegation of indefiniteness; however, it is submitted that the word "aperture" has ordinarily always been understood to mean diameter in the absence of an inventor being his own lexicographer and providing a different meaning than the ordinary meaning. Further, as additional evidence that the word "aperture" is understood in its ordinary meaning to mean the diameter of an opening, applicant has enclosed herewith, a copy of page 94 of Webster's Ninth New Collegiate Dictionary to confirm the same.

Accordingly, claim 5 is not indefinite for the manner in which it presently recites that term aperture.

In view of the foregoing amendments, remarks and arguments, it is believed that the application is now in condition for allowance, and early notification of the same is earnestly solicited.

Dated: December 15, 1998.

Respectfully submitted,


Kenneth L. Richardson
Attorney for Applicant
Registration No. 27,378

NATIONAL RENEWABLE ENERGY LABORATORY
1617 Cole Boulevard
Golden, Colorado 80401-3393
Telephone: (303) 384-7576
Facsimile: (303) 384-7499